A Robust, Cell-free Production System for On-Demand Protein Synthesis in Space

Completed Technology Project (2016 - 2017)

Project Introduction

We will develop a new cell-free expression system that functions after rehydrating from a freeze-dried condition. Freeze-dried powder that can be stored or transported at room temperature with reduced volume and mass, thus decreasing mission risk and increasing flexibility in production. Recently D. radiodurans ultrafiltrate (extraction of low molecular size compounds < 3.5 kDa) has shown the capability of protecting freeze-dried enzymes from ionizing radiation suggesting that D. radiodurans cell-free lysate is most likely contains natural anti-oxidants[1]. No work has been reported on developing a cell-free expression system with extremophiles. We will to develop an extremely stable cell-free expression system using D. radiodurans cell lysate and evaluate the performance of protein expression after freeze-drying and rehydration

Anticipated Benefits

Our inability to store and transport biomolecules such as vaccines, antibodies, nutrients and other protein-based materials and biosensors will limit long-term human missions as recognized in TA6.3, “Human Health & Performance”. Biological organics, such as proteins and vitamins, are sensitive to enzymatic decay, destruction by desiccation and radiation or radiation-induced oxidation caused by reactive oxygen species. Transport under extreme conditions such as high temperature, radiation and extreme desiccation exacerbate the situation. Thus, the typical stability of live attenuated influenza vaccines is < two weeks at 37 °C in aqueous solution, and only one year freeze-dried. The most common way to aid preservation and decrease fungal and bacterial contamination for influenza vaccines is by the addition of Thimerosal, which is approximately 50% mercury by weight. But mercury adds to toxicity. Similarly, Vitamin A is sensitive to oxidative degradation and even with the latest antioxidant system composed of generally accepted food additives, 15% will be degraded after 24 weeks at room temperature

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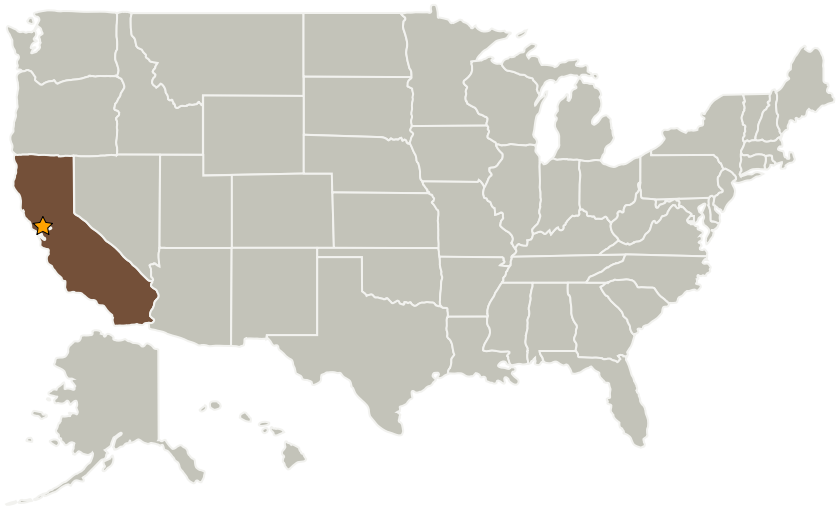
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Earth-Life Science Institute	Supporting Organization	Academia	Tokyo, Outside the United States, Japan
Lawrence Livermore National Laboratory(LLNL)	Supporting Organization	R&D Center	Livermore, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

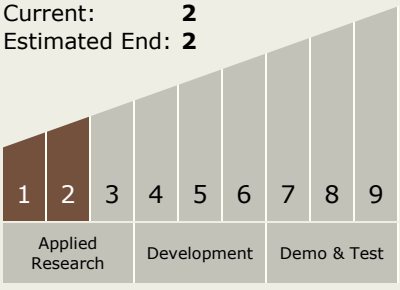
Harry Partridge

Principal Investigator:

Lynn J Rothschild

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



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Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.5 Radiation
    - TX06.5.1 Radiation Transport and Risk Modeling

Target Destinations

Earth, The Moon, Mars